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Accurate Measurement of Femoral Offset:

Clinical comparison of CT Scans, AP-Pelvis and AP-Hip Radiographs

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Background

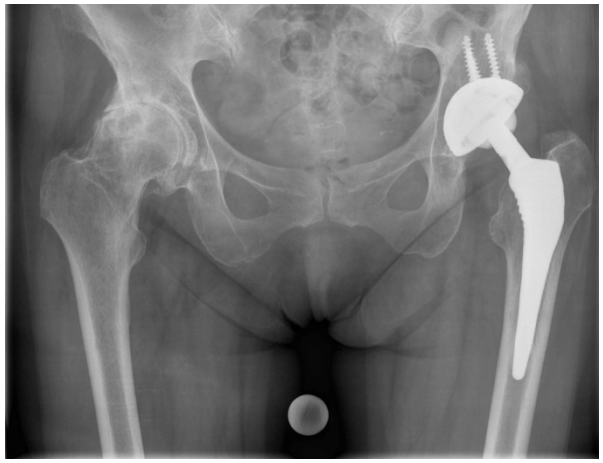
Accurate restoration of femoral offset (FO) essential for THR outcome.

- Improves abductor muscle strength
- Increases range of motion
- Minimises risk of limp, dislocation and wear related failure.

Background

Ways to measure femoral offset:

Pelvis X-ray

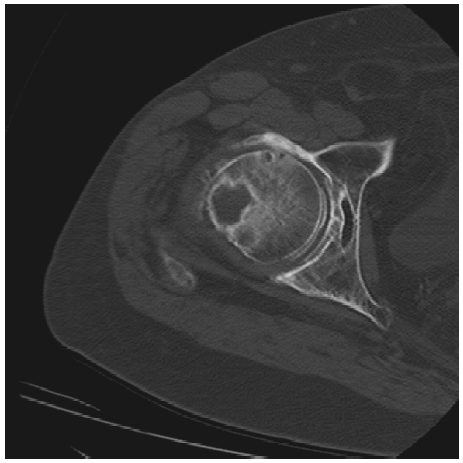


Most Common

Hip X-ray

Rarer

CT



'Gold Standard'
BUT high expense and dose

<u>Question:</u>

Will centering the X-ray beam on the femoral head rather than pubic symphysis improve femoral offset measurement?

Methodology

- Retrospective cohort study

100 Patients	43 Males	57 Females
Mean Age 61 yrs	Min age 45 years	Max age 74 years
Mean BMI 27 kg/m^2	Min BMI 20 kg/m^2	Max BMI 45 kg/m^2

All with primary hip osteoarthritis

- Radiographs

  AP-pelvis (beam centered on pubic symphysis)

  AP-hip (beam centered on femoral head)

  All radiographs taken in supine position, 15 internal rotation

  AP-hip, if neck not in line, hip elevated with a cushion.

- CT scans

  Supine position, legs neutral rotation

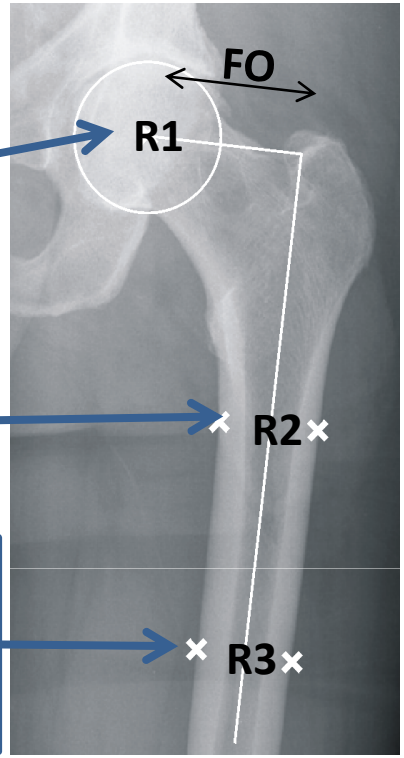
Methodology

- Measurement of Radiographs

R1: Circle tool used to define head diameter and centre

R2: Two manually selected medial and lateral points 20 mm below the lesser trochanter

R3: Two manually selected medial and lateral points at femoral isthmus.

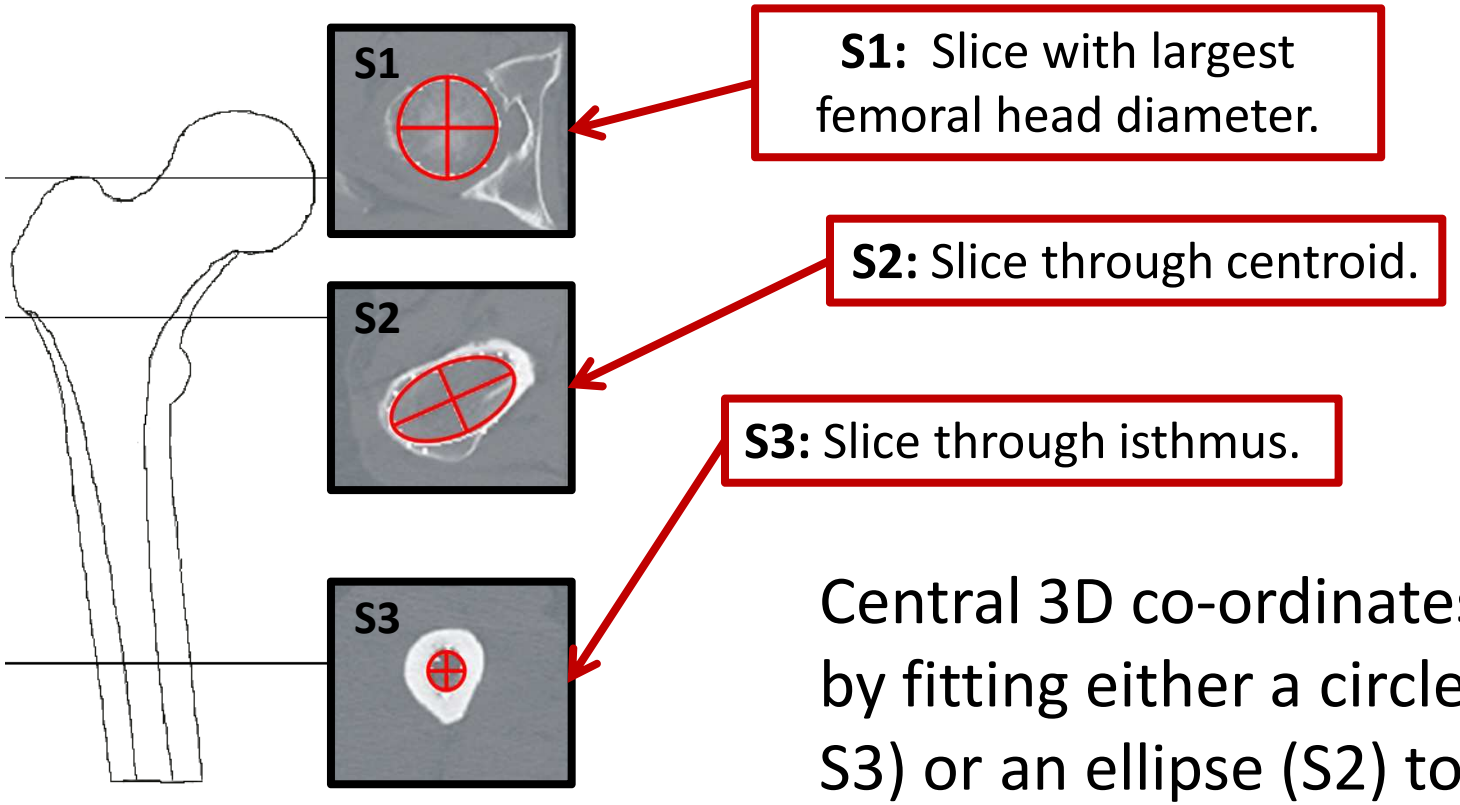


Femoral Offset (FO) = shortest distance from R1 to line R2-R3.

On AP-pelvis radiographs, distance from midpoint of teardrops to centre of femoral head calculated to show distance from centred beam (*x*).

Methodology

- Measurement of CT scans



Central 3D co-ordinates found by fitting either a circle (S1 and S3) or an ellipse (S2) to manually selected points

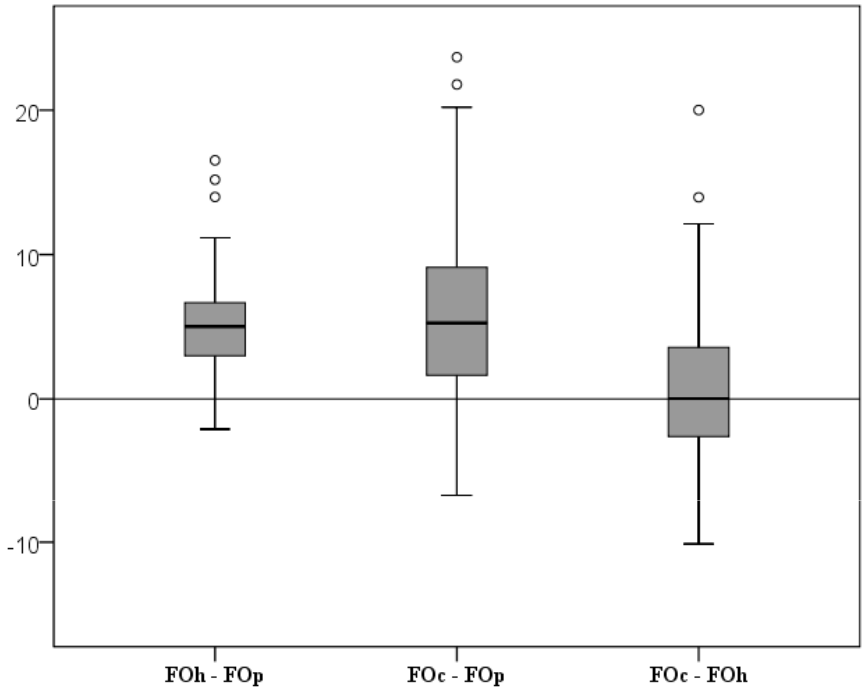
Femoral Offset = shortest distance from S1 to line S2-S3.

Results

	Mean FO / mm	95% CI
AP-pelvis (FOp)	39.0	37.4 - 40.6
AP-hip (FOh)	44.0	42.4 - 45.6
CT scans (FOc)	44.7	43.5 - 45.9

- AP-pelvis measurements underestimated
- Measurements out by more than 5 mm

Results

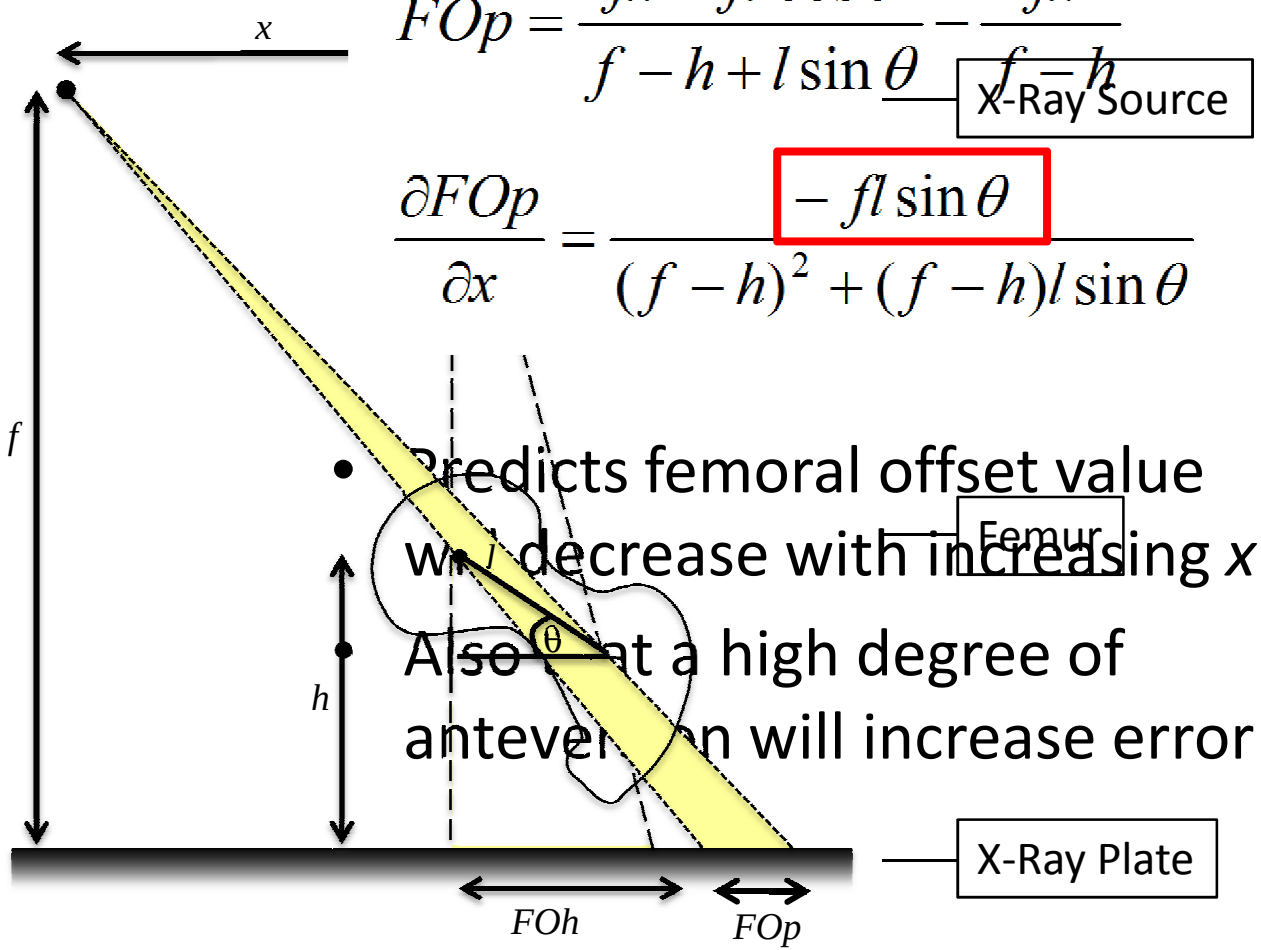


- No significant difference between AP-hip (FOh) and CT scan (FOc) measurements ($p = 0.191$)
- FOp significantly higher than FOc and FOh ($p<0.001$)

Theoretical Model

$$FOp = \frac{fx + fl\cos\theta}{f - h + l\sin\theta} - \frac{fx}{f - h}$$

$$\frac{\partial FOp}{\partial x} = \frac{-fl\sin\theta}{(f-h)^2 + (f-h)l\sin\theta}$$



- Predicts femoral offset value will decrease with increasing *x*
- Also that a high degree of anteversion will increase error

Discussion

But our cohort data did not fit the theoretical model

The scatter was too large...

Discussion

If the neck is not perpendicular to the beam, femoral offset is underestimated

$$\frac{\partial FOp}{\partial x} = \frac{-fl\sin\theta}{(f-h)^2 + (f-h)l\sin\theta}$$

Cannot always correct positioning in AP-pelvis X-rays

But more correction possible with AP-hip X-rays.

So error in femoral offset not only due to centering the beam.

Conclusions

- Femoral offset it underestimated on AP pelvis views.
- But can be accurately assessed on AP hip radiographs.

Further Work

- Correction factor for pelvis radiographs
- Analysis on a larger cohort size currently in progress.

Any Questions?